BULL. BOT. SURV. INDIA
Vol. 7. Nos. 1-4 : pp. 267-275, 1965

TERMINALIOXYLON TOMENTOSUM spec. nov. A FOSSIL WOOD FROM GHALA (GUJARAT STATE) BELONGING TO THE FAMILY COMBRETACEAE

T. S. Mahabale and S. R. Deshpande

Botany Department, University of Poona, Poona, India

A Tertiary locality well known for Nummulitic beds occurs at Ghala (Lat. 73°E and Long. 20°N) in Surat District, Gujarat State. It is approachable from Kim, a station on the Western Railway, through Tadkeshwar, about seven miles from Kim. Ghala is further two miles on the banks of the river Tapti. The specimen was collected from a place to the South of Tadkeshwar near Ghala*. In addition to this our collection includes some red algae already known from this place. Previous authors such as Malcolmson (1844), Carter (1854), Wynne (1868), Blanford and Stoliczka (1869), Vredenberg (1906), Rao (1941), etc. have studied algae, foraminifers and animal fossils from this place. Wynne (1868) had obtained some fossil wood in addition to pectan, foraminifers, and molluscs. No details of the wood were given by him or other authors who had collected it. Hence it was thought worthwhile describing this piece of fossil wood obtained from this less known locality. It belongs to dicotyledons and shows many interesting features described below :

DESCRIPTION

It is a piece of chert 4 × 5 × 3 cm (Text Figs. 2 and 3 and Pl. I, fig. 1). It was lying in an open field full of small *Nummulitic* discs washed out from the surrounding Tertiary strata. However, it should be stated that it was not found *in situ* and hence it is difficult to know its exact origin. It is a dark coloured chert nicely preserved. Due to partial weathering it looks ash-coloured from outside. On sectioning, the matrix looks brown. Growth rings are not visible under a hand lens, but only small white dots of vessels and broad rings of wood fibres around them scattered throughout. Between the fibre strips a few large cells of vasicentric parenchyma are also seen at places. The wood obviously appears to belong to diffuse porous type (Pl. I, fig. 2). Even under microscope growth rings are not visible but only the vessels and radial rows of wood fibres, paratracheal parenchyma and medullary rays.

Vessels are large, 173-333μ in diameter, average being 215μ. The distribution of vessels is 6-8 per mm^2. They are round or oval, solitary or in groups of 2, 3 or sometimes 4 cells in radial rows (Text Figs. 1, 4 and Pl. I, figs. 3 and 4). They have thick walls. Intervessel pittings are seen as large vestured pits in L.S. (Text fig. 7). The wood fibres are well preserved. They are aseptate, thick-walled, libriform and with simple pits. In T.L.S. they run zigzag (Text Fig. 5 and Pl. I, fig. 6). Parenchyma is paratracheal, vasicentric, sometimes tending to become aliform (Text Fig. 4 and Pl. I, figs. 3 and 4). Parenchyma cells surrounding the vessels are larger than those lying outside them. They vary from 40-60μ in diameter.

The medullary rays are homogeneous, 20-22 per mm^2, evenly distributed. Height of the rays varies from 5-11 vertical rows of cells, measuring 120-250μ. The diameter of rays cells is 40μ and width as seen in T.S. is 61μ. In T.L.S. they are uniseriate, sometime biseriate (Text Fig. 5 and Pl. I, fig. 6, *mr.*). Biseriate rays are about 20%, the great majority of the medullary rays being uniseriate. Some of the ray cells contain crystal-like bodies.

AFFINITIES

A careful examination of the above characters shows that the specimen compares well with the woods of the Euphorbiaceae, Sapindaceae, Leguminosae and Combretaceae. The possibility of this wood belonging to the Euphorbiaceae however, has been ruled out, as the parenchyma here is not apotracheal and medullary rays are mainly uniseriate and homogeneous. In Sapindaceae the vessels are generally solitary and parenchyma apotracheal. In Leguminosae growth rings are distinctly visible and parenchyma forms aliform or confluent aliform pattern around the vessels. This is not the case here. So we are left with the family Combretaceae only, notwithstanding that the specimen shows a few characters in which it agrees with the characters of the above mentioned families. But in its more important characters, it agrees mostly with the diagnostic characters of the family Combretaceae, such as vessels mostly medium-sized, either exclusively solitary or with multiples of cells, perforations simple, intervessel pittings alternate, parenchyma typically aliform or vesicentric. Medullary rays typically uniseriate or rarely biseriate, homogeneous or slightly heterogeneous. Fibres libriform with simple pits, aseptate, a few of them being septate.

---

* Encircled flagstaff on map indicates position where specimen was found.

Among common genera of the Combretaceae, the specimen shows a close similarity with the characters of the genus *Terminalia* in which according to Metcalfe and Chalk (1950, pp. 612-620) the vessels are mostly medium-sized, 200-300μ, 5-20 per mm^2, parenchyma predominantly paratracheal, aliform to confluent, rays exclusively uniseriate, only a few biseriate, about 4-6 per mm^2, homogeneous and composed of square or upright cells. Crystals inside the ray cells common. Fibres libriform aseptate.

Since the characters of the fossil specimen described here agree with these, it seems to belong to that genus. To ascertain this, it was referred to the late Dr. S. S. Ghose, Plant Anatomist, Forest Research Institute, Dehra Dun, who was kind enough to go through our slides and confirm the identification by comparing the slides of the fossil material with those of different species of the genus *Terminalia.* He further pointed out that it resembles very closely with the modern species, *Terminalia tomentosa* Wight & Arn. Prodr. Pl. II, figs. 8, 9, 11 show the structure of the wood in *T. tomentosa.* Comparing these with Text Figs. 1, 4, 5 and Pl. I, figs. 3, 4, 5 and 6 close similarity between the living species and the fossil wood becomes evident. Hence the identity of this fossil with *T tomentosa.*

PAST HISTORY OF THE GENUS *TERMINALIA*

The genus *Terminalia* is a large one and comprises 127 species in the world. Of these 12 species occur in the Flora of India. It is reported from the Tertiary floras of several countries and is represented by about 9 fossil species. The genus *Terminalioxylon* was constituted by Schonfeld in 1947 on the basis of material obtained from the Tertiaries of Columbia. The present species adds one more to the list making the total number of fossil species of *Terminalia* ten (see Table I).

Two fossil woods belonging to Combretaceae have been described by Boureau (1950, 1958). One of them is from the Tertiary of Indochina, *Terminalioxylon annamense ;* and the other, *T. fezzanense* from the deserts of Calancho, Africa. In India, two species of this genus have been described by Ramanujam (1956), *T felixi* Ram. and *T. speciosum* Ram. obtained at Mortandra in South India. To these two more were added by Navale (1955) from the same Tertiary beds in Arcot district in South India.

Another member belonging to this family, *Anogeissoxylon breveiseriatum* has been described from Mohgaon Kalan by Jain (1960, unpublished work).

Recently Uttam Prakash and Navale (1962) have described yet another species of *Terminalioxylon, T chowdhurii* from Barail Reserve Hills of Assam, the age of which is Middle Tertiary. *T chowdhurii* differs from the present material mainly in its parenchyma which is both paratracheal and apotracheal. It is only paratracheal in *T tomentosum.* In *T. chowdhurii* paratracheal parenchyma sometimes becomes confluent unlike that in the present specimen, in which the terminal parenchyma is banded.

Summarising the broad characters of the different species of *Terminalioxylon* so far known, including the new one described here, it will be seen that the present species differs from the others in having a combination of different characters individual to each species, agreeing in one or two characters with one species or the other, but not in the entirity of characters with any one of them. On the other hand, it agrees mostly with the characters of living species, *T tomentosa* and hence the new specific name.

AGE OF THE GHALA BED

The Ghala bed as described above lies on the bank of the river Kim which is a tributary of the river Tapti. An outcrop of *Nummulitic* bed containing red algae is exposed in this area. This according to Vredenberg (1960) belongs to Miocene to Pliocene age. Below the *Nummulitic* bed, an Intertrappean bed containing pebbles of chalcedony, tufa and non-fossilferous matter is found, mostly towards the Southern side of the village Tadakesar, dipping towards the river Tapti. In some of these beds pieces of wood are found, but not *in situ* at Ghala. Possibly they are drifted from another area above Ghala and are redeposited in the Tertiary bed of the conglomerates lying above. It will be hazardous to base any positive conclusion on the basis of a drift wood. But since it is found in the uppermost Intertrappean bed below Miocene-Pliocene, its age would be Oligocene to Miocene. This would be in accordance with the current geological opinion regarding the age of the strata of this area.

But more interesting than the age of this area is the fact that this wood belongs to Combretaceae, and is similar to that of *Terminalia tomentosa* Wight & Arn. Prodr. This species is found in the living flora of this area as well as elsewhere in the Dang Forests about 50 miles to the SE of this area. It is also common in the deciduous forests of the Deccan. From the past history of the genus, it seems that more than one species of *Terminalia* were growing in the Tertiary Flora of the Peninsular India, as they have been reported from the Miocene beds of Cuddalore Series in South India, Tertiary beds of Assam (Uttam Prakash, 1963), but not from the Eocene flora of Mohgaon Kalan (Dist. Chindwara). On the other hand, another genus of the same family, namely, *Anogeissoxylon*, is known from Mohgaon Kalan as reported by Jain (1960). The presence of another member of the Combretaceae, namely, *Terminalioxylon tomentosum n. sp.* in Gujarat, far away from Mohgaon Kalan, Cuddalore, and Assam, is rather interesting as it considerably extends the range of distribution of the family Combretaceae in the Tertiary floras of India, as well as that of the genus *Terminalia*.

The genus *Terminalia* Linn. is mostly spread in India, Africa, Java, Sumatra and Malaya. In the present day flora of Western India 12 species of it are found, of which *Terminalia tomentosa* Wight and Arn. Prodr. is one. Apparently this is an ancient species and its structure possibly presents more primitive characters in its vasicentric parenchyma and libriform aseptate fibres.

Terminalioxylon tomentosum spec. nov.

Diagnosis : A piece of chert having diffuse porous wood ; growth rings absent. Vessels visible as small dots, solitary or sometimes in radial groups of 2 to 3 cells : distribution 6-8 per mm ; oval to round ; medium to large, 173-330μ in diameter ; perforations simple ; intervessel pits large, simple, circular in outline.

Fibres thick-walled, libriform with simple pits ; medium, 20-30μ in diameter aseptate, arranged in regular radial rows except in the region of paratracheal parenchyma ; fibre cells circular or squarish in transverse section.

Parenchyma abundant, paratracheal, vasicentric to aliform ; 40-60μ in diameter.

Rays numerous 20-22 per mm ; evenly distributed ; mainly uniseriate, some biseriate ; height of the ray 5-11 cells or 250μ homogeneous ; ray cells about 40μ in diameter ; some of the ray cells have crystal-like contents.

Holotype No. 65 and slide Nos. 651, 652, 653, 654, 655, 656, 657 and 658 deposited in Paleobotany Museum, Department of Botany, University of Poona, Poona-7.

Locality : Ghala (District Surat, Gujarat State).

Horizon : Deccan Intertrappean Series.

Age : Eocene.

The authors wish to express their thanks to the late Dr. S. S. Ghose for examining their slides.

LITERATURE CITED

BLANFORD, W. T. On the traps and Intertrappean beds of Western and Central India. *Mem. Geol. Surv. India* 6(2) : 137-162, 1867.

BOUREAU, E. Contribution a l'etude palexylologique du l'Indochine III. *Terminalioxylon annamense* n.sp., Combretaceae des argiles neognes du Sud de l'Annam Central, *Bull. Du Service Geologique de l'Indochine* 29(4) : 5-11, pl. i, 1950.

—— Etude Paleoxylogique du Sahara (XXIV) : Sur le *Terminalioxylon Fezzanense* n.s.p., Combretaceae. Fossile du Desert du Elancho (Fezzan Oriental). *Bull. Mus. Nat.* 2 Serie 30(3) : 321-327, 1958.

JAIN, R. K. Further studies on the Flora of the Deccan Intertrappean series (Unpublished thesis), 1960.

MALCOLMSON, J. G. On the fossil of the eastern portion of the great basaltic district of India *Trans. Geol. Soc. Lond.* 5 : 537-575. (Printed in the Geological papers on Western India, edited by J. H. Carter. 1857. Education Society, Press, Bombay), 1-47, 1844.

METCALFE, C. R. AND K. P. CHALK. *Anatomy of Dicotyledons.* Vols. 1 and 2. University Press, Oxford, 1950.

NARAYAN RAO, S. R. *Lepidocyclina* from the agate conglomerates near Surat and Broach (W. India). *Curr. Sci.* 8(4) : 167-168, 1939.

—— On some foraminifera from the Tertiary beds near Surat and Broach (W. India) with special reference to the occurrence of Siderolites. *Ibid.* 2 : 78-79, 1939.

—— The Tertiary sequence near Surat and Broach (W. India) with description of foraminifera of the genus *Pellatispira* from the upper Eocene of this region. *J. Mysore Univ.* 2(2) : 5-17, 1944.

NAVALE, G. K. B. On the two new species of *Terminalioxylon* Schonfeld from the Tertiary beds of South India. The *Palaeobotanist,* 4 : 35-40, 1955.

PRAKASH, U. & G. K. B. NAVALE. *Terminalioxylon chowdhurii sp. nov.*, a new fossil Dicotyledonous wood from the Tertiary Rocks of Assam. *Ibid.* 11(1 & 2) : 49-53, 1962.

RAMANUJAM, C. G. K. Fossil woods of Euphorbiaceae from the Tertiary Rocks of South Arcot. Dist. Madras. *J. Indian bot. Soc.* 35(3) : 284-307, 1936.

—— On the two new species of *Terminalioxylon* Schonfeld from the Tertiary rocks of South Arcot Dist. Madras. *Ibid.* 37(1) : 128-137, 1956.

SCHONFELD, G. Hoelzer aus dem Tertiar von Kolumbien. *Slenkenber. Naturf. Ges.* 476 : 1-53, 1947.

VREDENBERG, F. W. *Rec. geol. Surv. India* 34 : 79-95 (as cited by Wadia 1953), 1906.

WYNNE, A. B. Geology of Surat. *Ibid.* 1(2), 1868.

EXPLANATION TO TEXT FIGURES AND THE PLATES

Plate I, figs. 1-6. *Terminalioxylon tomentosum* spec. nov. Mahabale and Deshpande.

1. Fossil specimen No. 65 × n.s. 2. T.S. of the same, surface view after cutting × 4. Note conspicuous vasicentric parenchyma. 3. T.S. of wood magnified × 32. 4. The same showing vessels ×96. 5. R.L.S. showing medullary rays-*mr* × 64. 6. T.L.S. showing uniseriate and biseriate medullary rays magnified-*mr* × 64.

Plate II, figs. 7-12. *Terminalioxylon tomentosum* spec. nov. Mahabale and Deshpande.

7-8. T.S. showing the vessels and surrounding tissues magnified × 480. 9. Corresponding view of stem in *Terminalia tomentosa* Wight and Arn. Prodr. showing xylem ×160. 10-11. T.L.S. of *Terminalioxylon tomentosum* Mahabale and Deshpande showing medullary rays-*mr* × 20. 12. *Terminalia tomentosa* Wight and Arn. Prodr. growing in Western Ghats (Winter aspect).

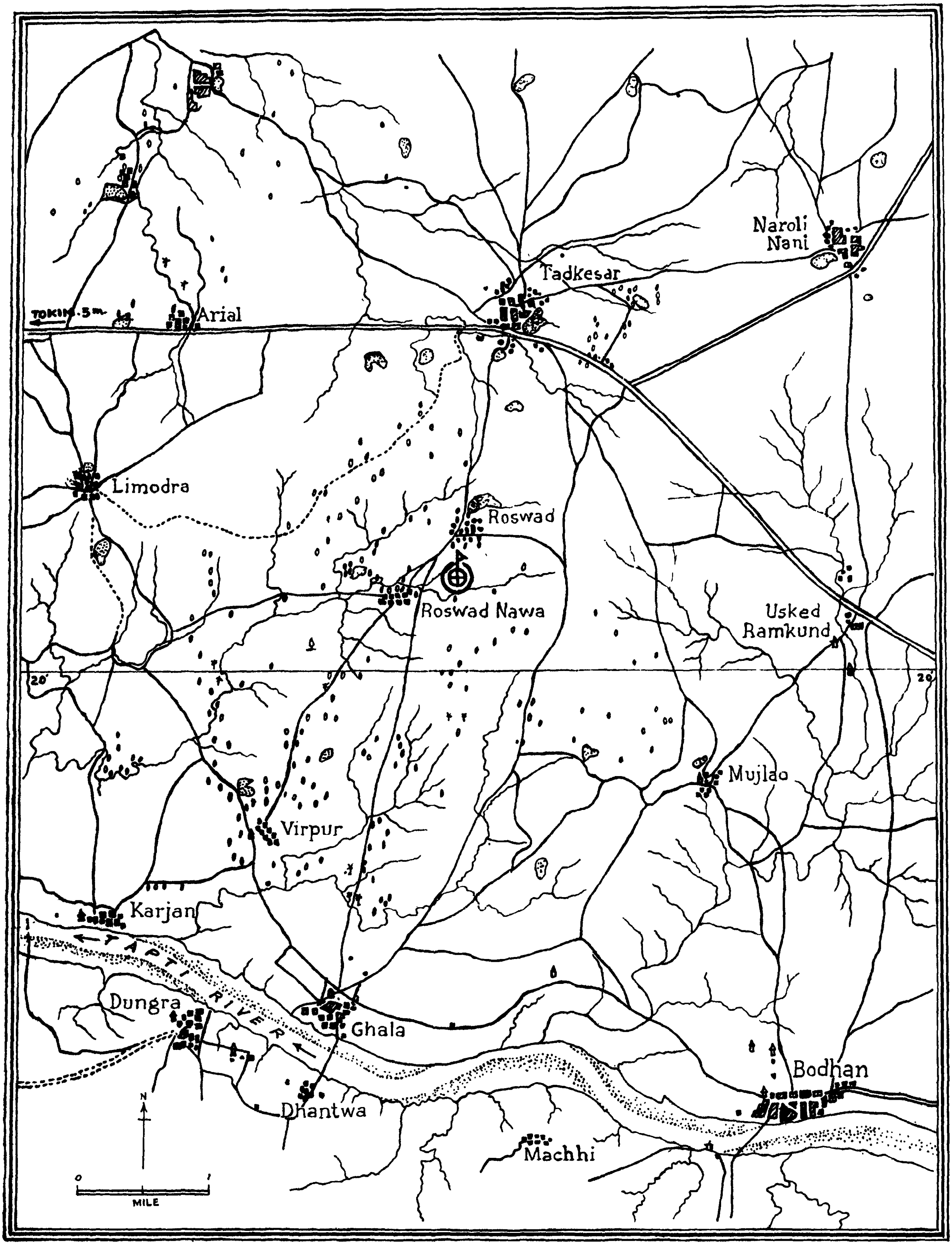
Text figs. 1-7. *Terminalioxylon tomentosum* spec. nov.

1. T.S. showing vasicentric parenchyma (diagrammatic) × 18. 2. fossil specimen No. 65 × ¼. 3. Surface view of the same, fractured × ¼. 4. T.S. of wood enlarged. showing fibre-*f*, medullary rays-*mr*, vascicentric parenchyma-*p* and vessels-*v* × 45. 5. T.L.S. of wood showing uniseriate and biseriate medullary rays × 113. 6. R.L.S. showing medullary rays-*mr* × 45. 7. A vessel in L.S. showing vestured pits × 507.

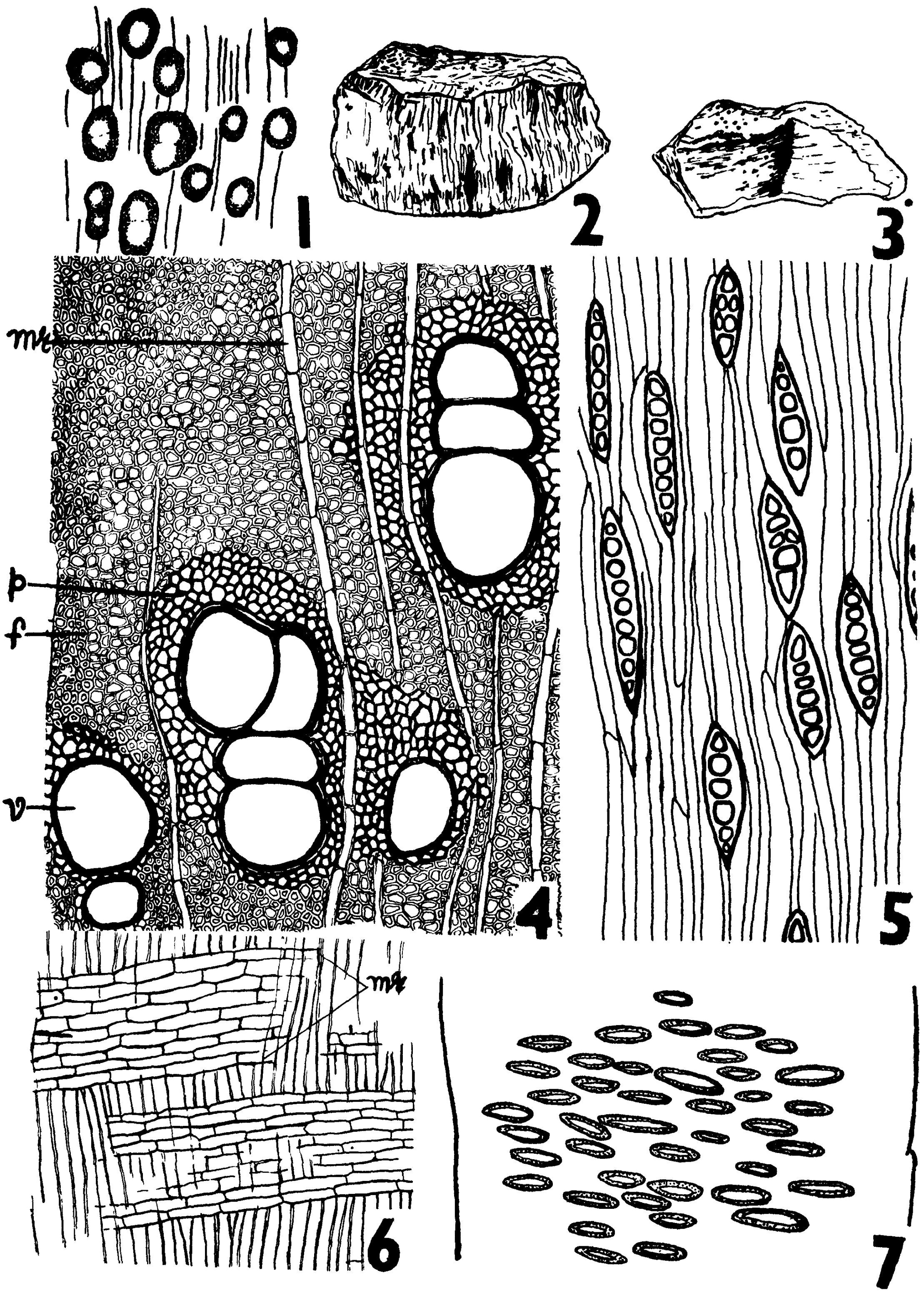
TABLE I

Comparative statement of characters of the different fossil species of *Terminalioxylon*

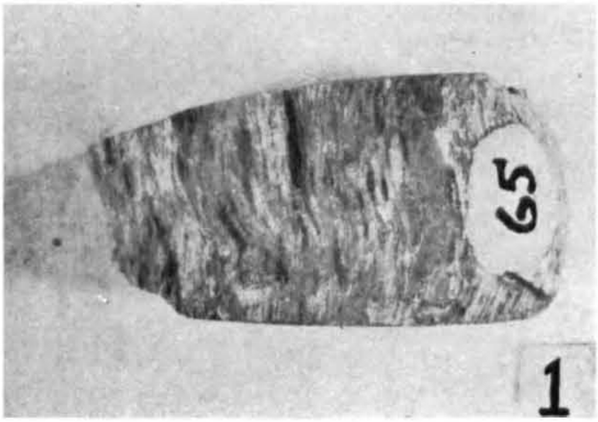
Sr. No. and Species	Country and the locality	Age	Author and year	Vessels	Parenchyma	Rays	Fibres
1	2	3	4	5	6	7	8
1. *T. naranjo*	Columbia	Tertiary	Schonfeld 1947	Diffuse, medium-sized, 120-160μ, solitary, also inradial groups	Abundant, paratracheal aliform confluent	Mostly uniseriate; 15-20μ in dia., 20-25 cells in height	Libriform
2. *T. porosum*	Columbia	Tertiary	Schonfeld 1947	Uniform, large, 150-300μ, solitary, sometimes in radial groups	Abundant, paratracheal aliform confluent, 2-3 layered	Mostly uniseriate, 15μ in dia., 20-40 cells in height	Libriform
3. *T. annamense*	Indo-China	Tertiary	Boureau 1950	Diffuse, tendency to be oblique, solitary, also radial, large, 150-300μ in diameter	Paratracheal, aliform and also apotracheal. Contains secretary cells	Uniseriate to biseriate with homogeneous and heterogeneous cells	Libriform and septate
4. *T. fezzanense*	Africa	Tertiary	Boureau 1958	Diffuse, solitary (93%) or radial groups of 2 (50%) exceptionally in radial group of 3 (10%) 4 or 5. 100×120μ; 5-13 mm, tendency to oblique vessel ending	Paratracheal, aliform to confluent; 30μ dia.; apotracheal 20 × 25μ	Uniseriate, exceptionally biseriate, homogeneous	—
5. *T. mortandrense*	Pondicherry South India	Tertiary	Navale 1955	Diffuse, 120-180μ. medium-sized, solitary and in radial groups of 2-3	Not abundant; paratracheal vasicentric and rarely aliform, not forming sheaths	Mostly uniseriate, 10-15μ in dia., 10-20 cells in height and homogeneous	Septate
6. *T. sahnii*	Pondicherry South India	Tertiary	Navale 1955	Diffuse, 120-130μ, solitary	Abundant; paratracheal often as tangential bands of 4-5 layers	Mostly uniseriate, 20 cells in height, 30μ in dia. and homogeneous	Aseptate
7. *T. speciosum*	South Arcot Dist. Madras, India	Tertiary	Ramanujam 1956	Diffuse, large, 180-270μ. solitary	Abundant, diffuse, paratracheal aliform and sometimes confluent	Uniseriate, and biseriate, 15-20μ in dia., 10-25 cells in height and heterogeneous	Libriform and aseptate
8. *T. felixii*	South Arcot Dist. Madras, India	Tertiary	Ramanujam 1956	Medium-sized. 130-150μ, solitary	Not abundant; paratracheal aliform sheaths and also apotracheal	Mostly uniseriate 20 cells in height and homogeneous	Libriform and aseptate
9. *T. chowdhurii*	Barail Reserve Hills, Assam, India	Tertiary	U. Prakash and Navale 1962	Diffuse, medium, 242-247μ in diameter, solitary sometimes in multiples of 2 or more. Often with tyloses	Both apotracheal and paratracheal, vasicentric to aliform, sometimes confluent forming 2-4-layered sheaths and the pore terminal parenchyma banded	Mostly uniseriate sometimes locally bicelled, homogeneous, 2-18 cells high with single crystal in each cell	Thick walled septate
10. *T. tomentosum*	Ghala, District Surat, Gujarat State, India.	Tertiary	Mahabale and Deshpande 1964	Diffuse, medium, 177-215μ, solitary. sometimes in radial groups of 2-3-4	Abundant, paratracheal vasicentric tending towards aliform type	Uniseriate and biseriate, 5-11 cells in height, 30-40μ in dia., homogeneous	Aseptate and Libriform



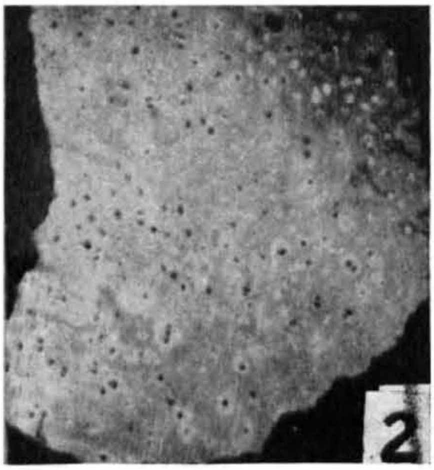
Map of Ghala locality

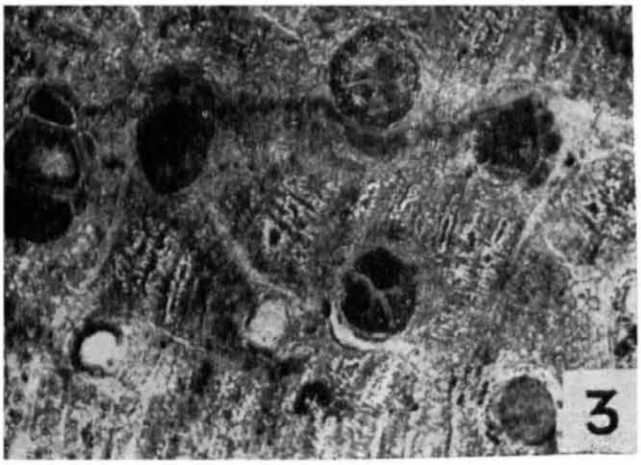


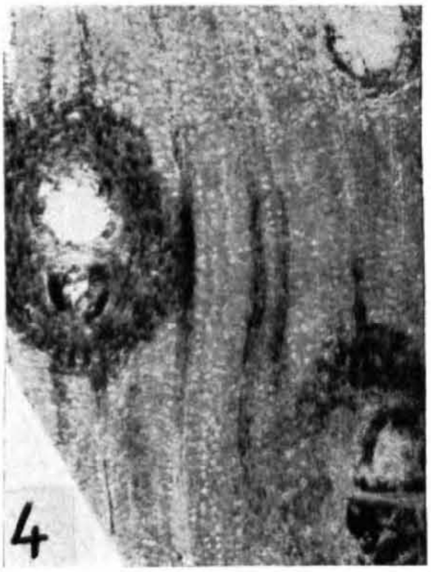
Text Figs. 1-7

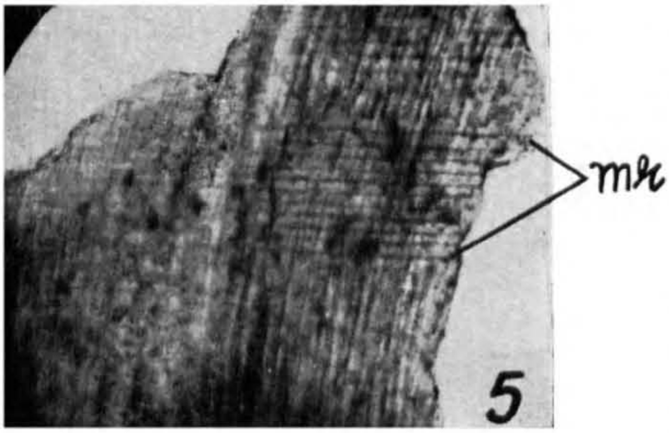


1

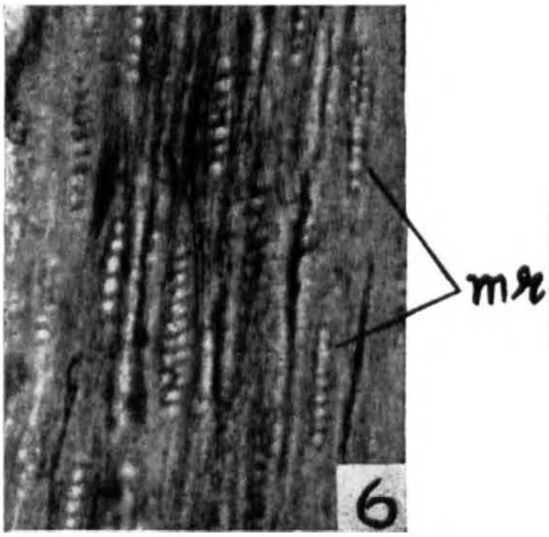

2


3


4

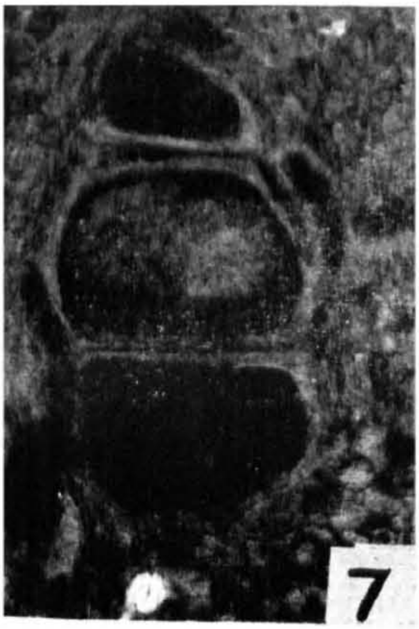


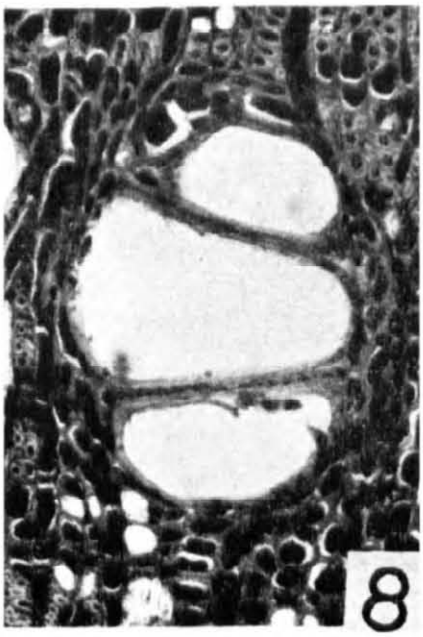
5

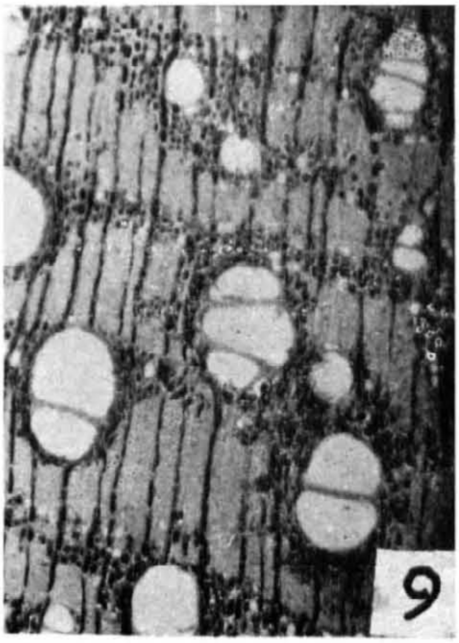


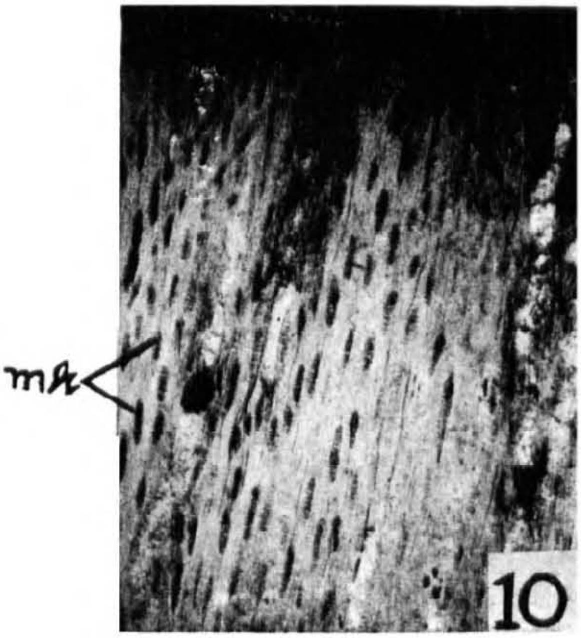
6

Plate I

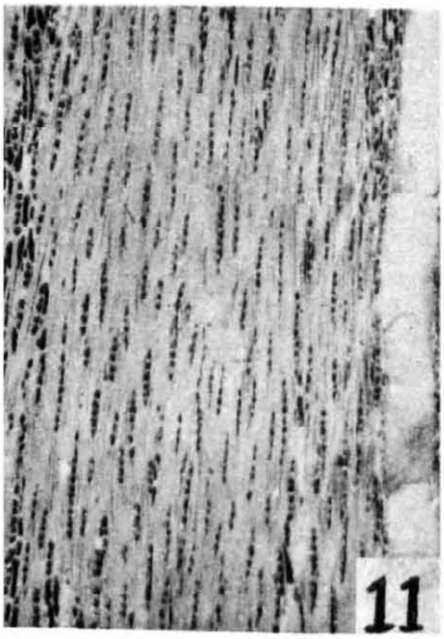

7


8


9



10


11

12

Plate II